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# USSR Report

## ELECTRONICS AND ELECTRICAL ENGINEERING

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5 March 1985

USSR REPORT  
ELECTRONICS AND ELECTRICAL ENGINEERING

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ACOUSTICS SPEECH & SIGNAL PROCESSING

UDC 534.851.3

TUBES AND TRANSISTORS IN AUDIO AMPLIFIERS

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 (manuscript received 29 Jun 83) pp 85-87

RESHETNIKOV, O.M., KHESTANOV, R.Kh. and CHERNYKH, Yu.V.

[Abstract] A study was made concerning the alleged difference between "tube" and "transistor" high-fidelity sound reproduction channels, in terms of subjective versus objective evaluation of reception quality. For testing was singled out the preamplifier stage behind the phonograph pickup, the Audio Research SP-6C tube preamplifier being compared with a specially built RIAA transistor preamplifier-corrector, so as to separate interaction of this stage from interaction of the output power stage with the acoustic part of the system. Tests were performed over a period of two months by the "blind" method, each test being performed twice using an A/B/X comparator (D. Clark, JOURNAL OF ACOUSTIC ENGINEERING SOCIETY Vol 30, No 5, 1982): first in position A (tube) and B (transistor) only and then also in position X for picking up randomized sound equiprobably identical to A sound and B sound, if those appeared different. According to expert listeners, there is no objective difference between tube and transistor preamplifier stages in terms of sound reception, the apparent difference detected in only two tests not having been subsequently reproducible. Even intentional degrading of the transistor preamplifier channel by replacement of its low-adsorption capacitors with conventional high-adsorption ones did not result in an objective difference. It still remains necessary to determine any difference between tube power amplifiers and transistor power amplifiers in terms of interaction with the loudspeaker. Figures 2; tables 1; references: 8 Western (1 in Russian translation).

[96-2415]

AEROSPACE & ELECTRONICS SYSTEMS

RADIOELECTRONICS AND SPACE EXPLORATION

Moscow RADIO in Russian No 8, Aug 84 pp 11-13

SARAFANOV, G., hero of the Soviet Union, pilot-cosmonaut of the USSR and BOGORODITSKIY, Yu. and MILYUKOV, I., engineers

[Abstract] Citing the 23 years since Yuriy Gagarin's first radio transmission from outer space, the authors summarize developments in radio communications and their role in mission control. Use of satellites for radio and television links with ground stations are an important part of information exchange. Construction and preventive maintenance activities by Soviet cosmonauts, use of radio technology for docking procedures and the reliability of such equipment, and the growing role of computer technology in space vehicles with human crews and pilotless craft are discussed. Automatic interplanetary vehicles that have landed on the moon, Mars and Venus, as well as artificial earth satellites, are facilitating weather and communication advances. Mock space equipment using radio and computer technology is of great importance for training cosmonauts. Despite all these practical applications, optimum utilization of automated equipment has yet to be achieved, and offers further challenge to Soviet and other engineers and technicians.

[78-12131]

SATELLITE COMMUNICATIONS AND AMATEUR RADIO

Moscow RADIO in Russian No 8, Aug 84 pp 21-22

ABOLITS, A., candidate of technical sciences, deputy chief, scientific research laboratory for space technology, All-Union Order of the Red Banner Volunteer Organization for Army, Air Force and Navy Cooperation of the USSR [DOSAAF]

[Abstract] This is a report on amateur radio use of "Radio-1" and "Radio-2" satellite communications since its beginning in October, 1978, which involves cooperation between DOSAAF and engineering and student design bodies. Second generation satellites "Radio-3" and "Radio-8" offered the possibility of an expanded system, and much work has been done to increase useful life and reliability of space radio communications. Soviet and foreign radio amateurs currently make use of this equipment, and competitions via earth

satellites have been organized. Of special importance are communications for scholarly, educational and practical purposes with Arctic and Antarctic stations. Most amateur communication satellites are in low orbits, with the exception of the "Phase-3" satellite of AMCAT. Commercial use and communications with remote areas with small populations are also discussed. Increased power and standardized design for wider uses are goals for development in coming years.

[78-12131]

ANTENNAS AND PROPAGATION

UDC 681.3

AUTOMATIC PICKUP OF TRAJECTORY BY METHOD OF SEQUENTIAL ANALYSIS TAKING INTO ACCOUNT DEVIATION OF RADAR MARKERS FROM CENTER OF STROBE

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 (manuscript received, after completion, 2 Jan 84) pp 28-30

KULIKOV, V.A. and SAPOV, M.M.

[Abstract] Sequential analysis is considered as an alternative to logic gating for confirmation of pickup of target trajectories by radar. Two markers are used for confirmation, after decoding of all new markers picked up during the scan. A sequential detector tests two alternative hypotheses, about the target's presence or absence, respectively, with the likelihood ratio estimated on the basis of new markers hitting or missing the strobe (region of space within which anticipated appearance of new markers is likely) on a given step of analysis. The main advantage of sequential detection is efficient elimination of spurious trajectories indicated by false markers appearing before secondary processing, but its drawback is protracted decision in the case of far targets and inevitable marker fluctuation. This drawback can be overcome by involvement of additional parameters in the detection process, most expediently the deviation of new markers from the center of the strobe (point within the strobe at which a given point of the target trajectory is anticipated). The payoff of this addition is an increment of the likelihood ratio on a given step of analysis and correspondingly a shorter decision process, assuming the same false-alarm and missed-hit probabilities as in the conventional confirmation algorithm. With the radial deviation used as additional parameter, this payoff is of the order of 25-30%. The probability of eliminating spurious trajectories is about the same in both algorithms, the proposed algorithm being preferable when the density of false markers is high but the conventional algorithm being preferable when it is low. Figures 4; references: 3 Russian.  
[96-2415]

ANTENNAS AND PROPAGATION

UDC 621.396.67

PERFORMANCE RANGES OF HELICAL ANTENNA MADE OF CONDUCTOR WITH EXTRA BENDS

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 (manuscript received 15 Nov 83) pp 77-79

DEMIDCHIK, V.I.

[Abstract] The performance of a single-thread helical antenna with uniform lead angle  $\alpha$ , made of a conductor bent into a meander with self-retardation determined by its height-to-period ratio, has been theoretically analyzed with experimental verification. Calculating the characteristics of such an axial-beam antenna requires solution of the Pocklington integral equation by numerical methods for the current distribution and its dependence on the  $k\alpha$  parameter ( $k$  - wave number,  $\alpha$  - radius of helix). As this parameter is increased from very small values to very large values, the amplitude distribution first changes from a standing-wave pattern with a peak perpendicular to the helix axis to a traveling-wave pattern with the amplitude decreasing exponentially over the initial helix turns and then again to a standing-wave pattern but now with a multilobe pattern and a peak at some angle to the helix axis. The rate of decrease of the current amplitude depends, moreover, in an inverse relation on the self-retardation of the antenna conductor or its height-to-period ratio and thus on the electrodynamic retardation of the current wave. The performance ranges of such an antenna are determined by the ellipticity factor in the  $(k\alpha, \alpha)$ -plane, which depends on the meander height and height-to-period ratio. The phase center of such an antenna lies on the axis and only shifts toward the free end as parameter  $k\alpha$  is increased. The directive gain remains approximately constant over the dipole range of axial beaming. The performance characteristics of double-thread and multithread helical antennas are similar, addition of threads resulting in a wider range of axial beaming with respect to directive gain and polarization. Experimental data confirm the theoretical results, minor differences being attributable to inaccurate evaluation of the ellipticity factor and to finiteness of the screen dimensions. The author thanks A.V. Runov for helpful discussions and N.V. Kalashnikov for assistance in calculations. Figures 2; references: 2 Russian.  
[96-2415]

BROADCASTING/CONSUMER ELECTRONICS

OPERATING TIME METER [FOR TAPE RECORDER]

Moscow RADIO in Russian No 8, Aug 84 pp 38-40

GANZBURG, M. and DYUFFEL', O.

[Abstract] As an alternative to standard tape counters for popular tape recorders, the authors have developed a photo-electric device for measuring operating time so as to give a precise reading of expended and available operating time. The device consists of two optical components in a slotted cylinder attached to the rubberized free-wheeling tension wheel. The first, third and fourth discharge circuits have a calculation coefficient of 10, the second, of 6. Technical features are diagrammed and described. The three components include the mechanical tension wheel and the plate on which the light- and photodiodes are mounted, the basic meter plate and light diode indicators and related components. If quality parts are properly mounted, no calibration is required. Features of mechanical tape regulation permitting smooth monitoring of tape movement may make the photoelectric device described unnecessary. Figures 3; reference: 1 Russian.  
[78-12131]

QUARTZ FILTER TRANSCEIVER

Moscow RADIO in Russian No 8, Aug 84 pp 24-27

LAPOVOK, Yakov Semenovich, [radio designer]

[Abstract] A technical description is presented of the latest transceiver design by Yakov Semenovich Lapovok, prize-winning designer whose works have appeared in the journal RADIO for 20 years. The transceiver described operates at 1, 3.5, 7, 14, 21 and 28 Mgh in CW and SSB modes, with a single frequency transformer and intermediate frequency of 8815 KHz provided by a commercially produced quartz filter. Dynamic range of 120 Db, signal measurements from S4 to S9+20 Db or +50 Db with input attenuator and independent frequency selection are some of the transceiver's features. Circuitry is diagrammed and explained, with further explanations promised in a subsequent issue. Figures 6.  
[78-12131]

MODERN CASSETTE TAPE RECORDER

Moscow RADIO in Russian No 8, Aug 84 pp 41-42

IZAKSON, I., ZAYKA, V., KOLESNIKOV, P., LUK'YANENKO, S. and GONCHAR, S.

[Abstract] Home tape recorders have either single universal amplifiers or separate recording and reproduction amplifiers. The present article describes the contradictions in using the same amplifier for both operations which comprise a serious shortcoming of current electronic equipment. The mechanical switches commonly used also have drawbacks, partly caused by "parasitic" connections between contact groups that permit high-frequency interference. Electronic commutators that contain bipolar and field transistors, optrons and other semiconductors, can eliminate many of these difficulties. Selection of high-quality tape, such as chromium dioxide tapes, can also improve quality. The various quality categories of Soviet tape recorders are discussed. The most complex (zero) group has an open channel with separate magnetic heads for recording and reproduction. Features of the reproduction amplifier of this type of recorder are summarized. Operating range is 30-18,000 hz, with nominal output voltage of 500 MV; other technical characteristics are also cited. Figures 2; references: 2 Russian.

[78-12131]

UDC 621.397.132:788.4

EXPERIENCE WITH EXPERIMENTAL STEREOSCOPIC COLOR TELEVISION BROADCASTING

Moscow TEKHNIKA KINO I TELEVIDIENIYA in Russian No 10, Oct 84 pp 25-30

DZHAKONIYA, V. Ye., DUBININA, Ye.A., DUKLAU, V.V., PETROV, V.S., UKRAINSKIY, O.V. and SHAPIRO, S.M., Leningrad Institute of Electrical Communication Engineering imeni M.S. Bonch-Bruyevich

[Abstract] Experiments on stereoscopic color television broadcasting in the Soviet Union began in 1979, jointly by the Leningrad Institute of Electrical Communication Engineering and the Leningrad Television Center. The single-objective system used for this purpose is compatible with existing black-and-white and color television broadcasting systems. A stereoscopic image pair is formed by the camera on the transmitter side, information about the spatial configuration of details being carried by defocusing parallaxial color frames through a green-blue and red objective to the photocathode. The image pair is viewed on the receiver side through a green-blue and red kinescope with a corresponding set of eyeglasses. The camera feeds electric signals to the monitor with eyeglasses through a camera channel where local and remote amplification is regulated, attenuation in cables is compensated, quench pulses for the receiver tube are added and clipped to the level matching black gradations of the video signal, nonlinearity of the receiver's modulation characteristic is gamma-corrected, white overshoots beyond the nominal swing of the video signal are suppressed and, in the yellow brightness channel horizontal as well as vertical sharpness is also corrected. An encoder rakes signals from the camera channel and forms a complete stereoscopic color signal compatible with SECAM signals. The performance of this experimental system is principally determined by the optical part of the transmitter, that is its ability to defocus images, code, and separate light signals through left-eye and right-eye channels of the stereoscopic pair as well as to suppress crosstalk between them. The feasibility of stereoscopic color television broadcasting is established. An analytical evaluation of the optical characteristics indicates a need to reduce further the vignetting effect by compensation and the scattering effect in polaroids as well as the nonuniformity of their spectral characteristics by filter arraying in the encoder. Figures 6; references 7: 6 Russian, 1 Western.

[101-2415]

UDC 778.533.5.001.24

METHOD OF DESIGNING MOTION PICTURE TAPE TENSION BOOSTER

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 10, Oct 84 pp 4-9

MELIK-STEPANYAN, A.M., Leningrad Institute of Motion Picture Engineers

[Abstract] The concept of a motion picture tape tension booster is developed which reconciles the contradictory requirements of a low tension for minimum wear of pergoration edges and a high tension for minimum wear of tape surface. The tension booster is a brake placed before the smooth take-up reel so as to ensure tight winding without an increase of tension on the tape leaving the unwound sprocket reel. Design of such a booster is based on optimization of the force balance in terms of the ratio of tension on the outgoing side to the tension on the incoming side. The second important performance indicator is the ratio of braking force to friction force characterizing adhesion between the tape and the smooth reel, avoidance of tape slippage requiring that this ratio be smaller then unity. The friction force is calculated according to the Euler relation for belts with the product of friction coefficient and embrace angle in the exponential factor. The tensions are referred to a system of coordinates which accounts for the changing of both radii, in opposite direction, during the unwind-wind process. Three possible design variants are: 1) with constant braking force; 2) with variable braking force, proportional to tension on the outgoing side as the latter increases; and 3) with variable braking force, inversely proportional to the tension on the incoming side as the latter decreases. For design purposes, these three variants are evaluated comparatively in both winding and unwinding modes, considering the expediency of using two identical boosting brakes in series. A numerical analysis of typical tape transfer from one reel to another indicates that a booster with constant braking force is most suitable when the tensions at both reels remain nearly constant during the process. The other two booster variants are most suitable, respectively, when tension at the unwound sprocket reel decreases or when the tension at the wound smooth reel increases in the process. Figures 7; tables 1; references: 3 Russian. [101-2415]

UDC 621.374.38

SUMMATOR OF RADIO PULSE SIGNALS

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 (manuscript received,  
after abridgment, 12 Dec 83) pp 83-85

MOSTYKO, V.S. and IVANOV, K.V.

[Abstract] A high-quality summator of radio-frequency pulse signals has been built for intermediate-frequency stages in radar receivers, particularly in channels where phase-keyed quasi-noise signals appearing with noise interference are processed. The summing circuit is connected on the input side to a commutator and is followed by a band-pass output amplifier. The commutator, containing 8 pairs of independently driven transistor switches, receives signals from a band-pass input amplifier through an 8-tap delay line and from a code generator through a control circuit. The experimental prototype of this summator has been tested and found to produce output signals with sufficiently small deviations (5-8°) of phase shifts upon cophasal summation (0°) or antiphasal summation (180°) as well as sufficiently small amplitude nonuniformity of the order of a few percent only, the latter being achieved by inclusion of trimmers in the commutator or in the summing circuit. The summator is suitable for a 50 MHz tuning range, its delay line being designed for radio signals of  $8\tau$  ( $\tau = 1.6 \mu s$ ) duration. Figures 3; references: 2 Russian.

[96-2415]

UDC 621.396.62:621.391.84

HIGH-FREQUENCY INPUT DEVICE FOR SUPERHETERODYNE RADIO RECEIVER WITH WIDEBAND PRESELECTOR

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 (manuscript received, after completion, 25 Apr 84) pp 37-40

SARAYEV, S.M.

[Abstract] An input device for a superheterodyne radio receiver with a wideband preselector and an array of switchable different band-pass filters is described. The device ensures high channel selectivity as well as adequate sensitivity at all combination frequencies during step-down frequency conversion. The performance of this input stage is evaluated in terms of frequency mismatches between the preselector filters and the symmetric mixer channel, these mismatches depending on the nonsquareness of the amplitude-frequency characteristics of the filters. Calculations for a 4-octave receiver with a 16-channel preselector indicate that the number of filters needed for covering the entire frequency range can be minimized by use of filters with bandwidth as well as upper and lower frequency limits appropriately chosen relative to the intermediate frequency. An additional frequency conversion in the upper half of the frequency range will further reduce the needed number of filters. Increasing the selectivity of the high-frequency input device will also increase the immunity to intermodulation and second-harmonic combination-frequency interference. Figures 4; references: 4 Russian.

[96-2415]

UDC 621.396.019.4

SYNTHESIS OF OPTIMUM RECEIVER AND PROCESSOR FOR SIGNAL PACKET OF RADIO PULSES

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 (manuscript received 15 Dec 83) pp 21-24

RYABTSOV, A.L.

[Abstract] A quasi-coherent optimum receiver and processor for a useful signal packet of radio pulses appearing in an additive mixture with a stationary normal white noise is synthesized in accordance with the Markov theory of nonlinear filtration. In addition to a period estimator, multipliers, a differentiator, and a summator, the structure of this device includes a shaper of unit-amplitude video pulse packets, a fine-tunable carrier-frequency oscillator, and a  $(0, \pi)$  phase keyer. The estimated error of period parameter filtration indicates that a packet of L radio

pulses has a signal-to-noise ratio  $L$  times higher than a single pulse. In the extreme case of zero filtration error and a payoff of using pulse packets  $M \rightarrow \sqrt{L}$  the a posteriori dispersion of the filtered period parameter is  $\sqrt{L}$  times smaller in a packet than in a single radio pulse. Figures 2; references: 4 Russian.  
[96-2415]

UDC 778.534.45.001.52

FEASIBILITY OF RAISING MAGNETIZATION LEVEL OF SOUND TRACKS ON PERFORATED CARRIER

Moscow TEKHNIKA KINO I TELEVIDIENIYA in Russian No 10, Oct 84 pp 10-13

ALEKSANDER, A.I., GEL'PERN, G.A. and KRASILEVA, V.I., TSKBK NPO "Keran" (Central Office for Cinematography, Scientific-Industrial Association "Ekran")

[Abstract] Maximizing the magnetization of tape for soundtrack recording is examined from the standpoint of harmonic distortion, which is the main limiting factor. As performance indicators are considered the composite harmonic distortion factor, rather than the third-harmonic ripple alone, and the also minimizable difference-tone factor. In an experimental evaluation, A3901 and A3904 tapes were magnetized to the 640 nWb/m level for recording of two signals with the frequency spectra  $f_1=3-8\text{kHz}$  and  $f_2=5.5-15.5\text{ kHz}$ , respectively, from two corresponding audio oscillators through  $(0.5-2.7)\pm10\%$  kohm adjustable resistors. The original sound tracks on a 25D34 recorder as well as five successive copies were checked by a frequency analyzer with a band-pass input filter, and on an oscilloscope. Voltages at the recorder input and output were measured with millivoltmeters. The results indicate that A3901 tape can be magnetized to the 640 nWb/m level rather than the 320 nWb/m level, with careful control of the recording equipment, but that A3904 tape offers a desirable extra quality margin. Figures 4; tables 4. references 7: 6 Russian, 1 Western.  
[101-2415]

UDC 621.397.2

TRANSMISSION OF TWO COLOR TELEVISION PROGRAMS OVER ONE COMMUNICATION CHANNEL

Moscow TEKHNIKA KINO I TELEVIDIENIYA in Russian No 10, Oct 84 pp 31-34

BEZRUKOV, V.N., ZUBAREV, Yu.B., KOSS, V.P., KUDRYAVTSEV, K.T. and NOVAKOVSKIY, S.V.

[Abstract] A method of transmitting television signals was proposed earlier which involves additional image discretization over groups of elements with arbitrary orientation, not necessarily horizontal or vertical, in space (ELEKTROSVYAZ' No 3, Mar 82 pp 11-15). On this basis, with discretization of the brightness signal, a variant of channel multiplexing is now proposed, with alternation of signals in time for transmission of two programs over one analog channel. Brightness discretization reduces the inevitable crosstalk distortion of the first and second kinds which attends discretization in time. The transmitter includes a program synchronizing and phasing device, a first-program processor, a second-program processor, and an output dial switch. The first-program processor contains a SECAM decoder, a two one-frame delay lines, a modulator, an adder, and two commutator switches to the second-program processor. All three switches and the adder are controlled by the synchronizer-phasing device. The receiver includes an input dial switch, a synchronizer-identifier, and two program restorers. The first-program restorer contains a color-difference signal decoder, two one-frame delay lines, two commutator switches to the second-program restorer, a switch to the identifier and another commutator switch, a real-time digital interpolator operating at 13.5 MHz in the first-degree Taylor series mode, a weighting adder and image movement detector, and a SECAM encoder. Figures 5; references 7: 6 Russian, 1 Western.

[101-2415]

UDC 621.385.832.822

DEVICE FOR CONTROLLING OPERATION OF LITHICON CATHODE-RAY MEMORY TUBE

Moscow TEKHNIKA KINO I TELEVIDENIYA In Russian No 10, Oct 84 pp 51-52

SMIRNOVA, I.A., Moscow Electrotechnical Institute of Communications

[Abstract] New cathode-ray memory tubes, lithicons, have been developed which record television frames on the target surface with adequate quality for broadcasting without spontaneous erasure of the potential profile after turn-off or during lengthy storage. A device for controlling the operation of a lithicon was subsequently developed which ensures application of the proper voltages to three tube components (modulator, signal plate, erasing electrode) during three stages of the operating cycle (preparation for recording, recording, readout with normal erasure) and storage. The device consists, accordingly, of three arrays of four voltage generators each and one array of control-pulse generators. Better control of analog devices such as memory tubes will ensure their competitiveness against digital devices. Figures 2; references: 3 Russian.

[101-2415]

UDC 621.397.611

STUDY OF MAGNETIZATION PROFILE ON ACTIVE SURFACE OF MAGNETIC HEADS BY  
MAGNETOOPTICAL METHOD

Moscow TEKHNIKA KINO I TELEVIDIENIYA in Russian No 10, Oct 84 pp 53-54

GRIBKOV, V.L., ZUBOV, V.Ye., KRINCHIK, G.S., LYSKOV, V.A., MUCHIYEV and  
NIKANOROV, S.I.

[Abstract] The magnetization profile of thin layers on magnetic heads was measured by the Kerr-effect magnetooptical method. Video recording heads for this purpose were magnetized with a reversal frequency of  $k$  kHz. The micromagnetometer had a sensitivity of  $10^{-5}$  to relative changes in light intensity and an area resolution of  $5 \times 1 \mu\text{m}^2$ . From the magnitudes of polar, meridional, and equatorial Kerr effects the magnitudes could be determined of longitudinal, transverse, and normal magnetization components. For calibration, both polar and equatorial Kerr effects were first measured in a saturating magnetic field. Measurements were made on approximately  $0.1 \mu\text{m}$  thick 10SYuVI (Fe-Al-Si alloy) films. The results revealed a nonuniform profile of the longitudinal magnetization component. Jumps and gradients, especially at grain boundaries, were found sporadically to reach magnitudes comparable with those under the active gap and to produce scattering fields comparable with those above the gap. This "second gap" effect of grain boundaries can be reduced by use of material with a finer grain structure. The different current dependence of the magnetization components indicates that reversal of the longitudinal component is effected by the mechanism of domain wall displacement, while reversal of the normal component is effected by rotation of the magnetization vector. Figures 3; references: 4 Russian.

[101-2415]

CIRCUITS AND SYSTEMS

UDC 681.3

ESTIMATING ALGORITHMIC ERROR OF DIGITAL RECURSIVE FILTERS

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 10, Oct 84 (manuscript received, after completion, 25 May 83) pp 65-68

KIRILLOV, VLADIMIR YUR'YEVICH, candidate of technical sciences, assistant, Moscow Aviation Institute

[Abstract] The algorithmic error in the output signal of a digital recursive filter synthesized on the basis of an analog prototype filter is estimated, considering that this error is caused by time discretization only and assuming that the discretization interval is known. The filter is treated as a linear system operating in the pulse mode and the effect of level quantization on the algorithm is disregarded. Analysis and calculations on this basis yield the maximum difference between the steady-state values of the output signal of such a filter and the discrete values of the output signal of an ideal analog filter, this difference being obtained from the particular solution to the differential equation of the filter. For a typical filter with the transfer function  $H(z)=KT/(1-e^{-T/T_1}z^{-1})$  and an input signal  $u(\tau)=\sin\omega\tau$  this error is 0.0516 when  $T_1=2s$ ,  $K=2$ ,  $T=0.1s$ ,  $\omega=1$  rad/s,  $\max|u'(\tau)|=1$ . References 7: 6 Russian, 1 Western (in Russian translation). [100-2415]

UDC 621.372.632

WIDEBAND PHASE KEYERS

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 (manuscript received 27 Dec 83) pp 82-83

GVOZDEV, V.I., LITVINENKO, M.Yu. and SEDLETSKIY, V.E.

[Abstract] A wideband  $0-\pi$  phase keyer has been developed on the basis of a hybrid ring bridge formed by a half-wavelength symmetric slot line, with an incoming straight symmetric slot line and an outgoing asymmetric

strip line connected at diametrically opposite points. The advantages of this device over a conventional one on the basis of a magic tee with an open loop formed by a quarter-wavelength asymmetric strip line are that diodes can be connected directly without matching devices and that a frequency-independent 180° phase shift occurs within the input tee. An experimental prototype of this new phase keyer was built on a 1-mm thick Polikor substrate with GaAs Schottky-barrier diodes. It was subsequently tested with a modulating 10 MHz meander signal. The results were a carrier attenuation of at least 30 dB over the entire 1.6-2.8 GHz range, with the loss on parasitic frequency conversion less than 7 dB per sideband and loss on the parasitic amplitude modulation not more than 0.3 dB, holding the nonuniformity of the amplitude-frequency characteristic below 2 dB. The design can be improved by various modifications such as using a 3/2 long symmetric slot line for the closed ring and adding two diodes so as to widen the dynamic range by a factor of 2, or diametrically shunting the ring with a high-impedance half-wavelength symmetric slot line so as to widen the frequency range. Figures 3; references 5: 2 Russian, 2 Western (2 in Russian translation).

[96-2415]

UDC 621.372.54.037.372

SYNTHESIS OF DIGITAL NONRECURSIVE BAND-ELIMINATION FILTERS FOR MOVING-TARGET SELECTORS

Moscow RADIOTEKHNIKA In Russian No 10, Oct 84 (manuscript received, after completion, 1 Nov 83) pp 41-44

KOZLOV, I.A. and MIRONOVA, T.V.

[Abstract] A synthesis of digital nonrecursive optimum Chebyshev band-elimination filters is shown, such filters of low order ( $n \leq 4$ ) being the simplest and thus most suitable for moving-target selection. They have an antisymmetric pulse response characteristic and a linear phase-frequency characteristic, their amplitude-frequency characteristic containing several equally large ripples in the stop band and one ripple in the pass band. The synthesis is based on a trigonometric polynomial derivable from an algebraic power polynomial by change of variables  $x \rightarrow \sin \frac{1}{2}\omega T$ . Such a filter can be designed for not less than the necessary attenuation in the stop band or for not more than the allowable non-uniformity of the pass band, also for a maximally wide stop band or a maximally side pass band. A filter of higher order becomes feasible upon widening the pass band so as that it will contain two or more ripples. This is demonstrated by the synthesis and design of a sixth-order filter in this class. Figures 2; references: 2 Russian, 1 Western (in Russian translation).

[96-2415]

UDC 621.372.54.037.372

METHOD OF DESIGNING DIGITAL BAND-PASS FILTERS WITH INFINITE MEMORY

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 (manuscript received 17 Dec 83) pp 8-13

VITYAZEV, V.V., MURAV'YEV, S.I. and STEPASHKIN, A.I.

[Abstract] A digital band-pass filter with infinite pulse response characteristic  $H(\omega)$  is proposed which consists of a digital comb filter with a frequency characteristic  $H_1(\omega) = H(\omega) +$  periodic sequence of side lobes and a digital smoothing filter with a frequency characteristic  $H_2(\omega)$  behind, the latter extracting the main lobe from the spectrum. The major problem of designing the comb filter with the necessary selectivity is treated as one of synthesizing some basal low-frequency filter by the Kaiser method. Both synthesis and subsequent performance analysis are demonstrated on a Butterworth filter with 3 dB attenuation at 10 Hz and at least 40 dB attenuation at 20 Hz, for discretization of input signals at a 10 kHz frequency. Figures 2; references 3: 1 Russian, 2 Western (both in Russian translation).  
[96-2415]

COMMUNICATIONS

EXPEDITING CAPITAL CONSTRUCTION

Moscow VESTNIK SVYAZI in Russian No 7, Jul 84 pp 2-3

RAVICH, I.S., USSR deputy minister of communications

[Abstract] According to a recent joint resolution by the CPSU Central Committee and the USSR Council of Ministers, it will be necessary to expedite capital construction. In the communication sector this means advancing the deadlines and meeting them. Trusts will be established for this purpose with heavy participation by construction and installation as well as equipment production, transportation, and delivery managing personnel. Among the priority projects requiring an intensive effort toward their overdue completion are cable and radio relay lines KM - 19 MP, KM - 18m, KM - 90 - 1, KM - lye, KM - 21, KM - 60, RRL - 163, RRL - 300, RRL - 150,200, and the Tyumen'-Surgut-Urengoy-Tazovskiy RRL, large automatic long-distance telephone exchanges in Kharkov and Minsk, and automatic switching stations at junction points. In the Moscow Metropolitan Telephone System there is a need to connect an additional 130,000 subscribers by the end of this year. Central administrations of metropolitan telephone systems and ministries of communications must supervise all activities aimed at ensuring adequate power supply and sanitation as well as training of personnel. Full utilization of available personnel and tools for excavating and cable laying operations, often underutilized and working one shift only, will be the responsibility of the Special Design and Technological Office at the Main Administration for Construction of Communication Equipment. Several "Promsvyaz'" equipment manufacturing plants require rebuilding of facilities for elimination of bottlenecks and delays. Among them are the Golitsyn base, the Navlya wood processing combine, and Avsyumin plant, and above all the Taldom plant. Better delivery of materiel and faster installation will provide overdue communication service to residential communities such as Khimki, Domodedovo, Yur'yev-Pol'skiy, Krasnoye Selo as well as to official agencies such as the International Post Office and even to the new "Promsvyaz" plant in Barabinsk. The traditional "Construction Day" holiday should be observed with a resolve to move on energetically with the job.

[83-2415]

## IMPROVING TECHNOLOGY OF CABLE-COMMUNICATION LINE CONSTRUCTION

Moscow VESTNIK SVYAZI in Russian No 7, Jul 84 pp 35-36

FARBER, Yu. D., candidate of technical sciences, laboratory chief, All-Union State Trust for Construction of Long-Distance Wire Communication Equipment

[Abstract] A new technology has been developed, following extensive scientific research, for installation of any kind of communication cable. It includes cable preconditioning and testing, precise quality control of installation and subsequent performance, fault locating and fault clearing particularly, and even such a special operation as burning out metal dust which has settled between wires in coaxial pairs. Thorough procedures and sufficiently sensitive instruments will be provided for making measurements in unattended repeater stations as well as in attended ones. Much attention was paid to economy measures, mainly to the development of labor-saving tools and techniques such as connection of the second cable ends to the lead-in cable racks. Another objective is to increase the bandwidth of symmetric cables by suppression of audible crosstalk between parallel circuits and to eliminate feedback circuit elements from the cable boxes. Whenever possible, conventional structures of solid metal have been replaced with metal mesh. It has become feasible to lengthen the distance between attended repeater stations and thus reduce the number of such stations. Development of multichannel communication systems, conversion from analog to digital data transmission, and conversion from electromechanical to quasi-electronic switching will further contribute to the overall cable communication economy, including a decrease in construction costs. Because installation of cables is the most expensive item in the total picture, it will be of the utmost importance that cable be delivered to the site together with the complete set of accessories, tools, and necessary materials. Figures 2.

[83-2415]

## PARTICULARITIES OF OPERATED METROPOLITAN TELEGRAPH COMMUNICATION SYSTEMS

Moscow VESTNIK SVYAZI in Russian No 7, Jul 84 p 37

SOLDATOVA, L.P., engineer, and KUBAKINA, T. G., engineer, Central Technical Control, Vladimir telegraph system

[Abstract] In the technical control room of the Vladimir telegraph system there is now installed not only TVU-12M"A" equipment, which has been here since 1974, but also TVU-12M"B" equipment. This, together with the ACT-3 automatic telephone crossbar in the same building, improves the communication service and facilitates necessary tuneups. A special technique has been developed for reducing excessive attenuation along a subscriber hookup line, namely the resistor R1 in "Ural-S" and "Ural-A" transmitter circuits is disconnected so as to raise the carrier-frequency signal voltage for the threshold device and then, if further necessary, a 10,000 pF capacitor is connected in parallel across resistor R27. Neither the quiescent point nor

the operating point is shifted as a result. One technician is specially assigned to the TVU-12M equipment, responsible for its maintenance as well as for maintenance of subscriber hookup lines. One deficiency of the TVU-12"B" equipment is in the protection of the  $\pm 60$  V power supply stabilizer against short circuits in the load, manual cutout being inadequate. A special cutout relay with automatic reclosure after fault clearance has, therefore, been installed to remedy the situation. From the managerial standpoint, precise division and assignment of responsibilities contributes to smooth implementation of corrective measures. Figures 1.  
[83-2415]

#### METHOD OF ESTIMATING CHANNEL UTILIZATION FACTOR IN LONG-DISTANCE TELEPHONE COMMUNICATION SYSTEM

Moscow VESTNIK SVYAZI in Russian No 7, Jul 84 pp 38-39

BORUKHOV, R.R., graduate student, All-Union Correspondence Institute of Electrical Communication Engineering, chief of Financial planning department, UzSSR long-distance telephone station, Tashkent

[Abstract] The cost effectiveness of capital investment in long-distance telephone communication systems can be characterized by a single natural parameter, namely the channel utilization factor. This factor is defined here as the ratio of the number of actual calls to the maximum theoretical number of calls. The latter is broken down into a weighted sum of manually, semiautomatically, and automatically made connections. A formula is then derived for that maximum theoretical number as the norm in terms of channel capacity, load concentration at peak time, and mean duration of calls - with 310 working days per year as reference base. Further analysis of each quantity involved here and their numerical evaluation with available empirical data yields a channel utilization factor of 0.86 for the UzSSR long-distance telephone station in Tashkent. The procedure can be readily extended to cover any given larger territory. An analysis of such estimates according to this procedure indicates, furthermore, how the channel utilization factor and thus the cost effectiveness of capital investment can be improved.

Figures 2.

[83-2415]

UDC 656.25:621.317

COMMERCIALLY PRODUCED SKA-1 STAND

Moscow AVTOMATIKA, TELEMEKHANIKA I SVYAZ' in Russian No 8, Aug 84 pp 7-11

BAL'SHEM, Ye.I., managing designer, Design Office of Main Administration of Signalization and Communication, Ministry of Railroads

[Abstract] The SKA-1 test stand for checking railroad signalization and interlock equipment (AVTOMATIKA, TELEMEKHANIKA I SVYAZ' No 4, Apr 84) includes a time measuring cell YaI-t and a capacitance measuring cell YaI-c. The holding time in the relay and repeater stages SVSh, BSVSh, BVMSh, KBMSh, RZFSSh is measured with an adapter and a checking device for prior accurate and distortionless reading of time in the stabililtron relay, which contains a vibration converter as a high-voltage power supply. The capacitance measuring cell measures the time taken to charge a capacitor from zero to the threshold level, this time being equal to the capacitor time constant and thus proportional to the charging circuit resistance. This cell consists of a comparator based on a K1UT401A operational amplifier, a KT315V transistor switch, a K11LA4 logic gate, a stabilizer of negative voltage, a two-transistor multivibrator, and a commutator relay with a one-transistor amplifier. The operation of both measuring cells and the sequence of readings can be programmed with the aid of pushbuttons or automated in the combination frequency meter and clock mode. Figures 8; tables 1.

[95-2415]

UDC 624.9:658.011.54

STEPS TOWARD INDUSTRIALIZATION AND MECHANIZATION OF CONSTRUCTION WORK FOR EQUIPPING SIGNALIZATION-CENTRALIZATION-INTERLOCK FACILITIES

Moscow AVTOMATIKA, TELEMEKHANIKA I SVYAZ' in Russian No 8, Aug 84 pp 3-7

ASS, E.Ye., laboratory chief, All-Union Scientific-Research Institute of Transportation System Construction, and GONCHAROV, A.Ya., chief of engineering department, Main Administration of Transportation System Electrification

[Abstract] Progress in industrialization and mechanization of construction work for signalization-centralization-interlock facilities along transportation routes such as railroad tracks is in evidence in both underground cable and overhead line installation. New equipment has been introduced for ground construction. This includes excavator trucks, power drills with cranes, cable laying machines, trucks for transportation of cable poles to erection sites with special derricks and other accessories. Similar progress in erection of overhead automatic interlock lines requires use of crossarms made of glass-plastic or polymer-concrete composite material instead of conventional insulators. With this special equipment is needed for mounting poles in anchored buckets in rocky soil, equipment for pre-assembly of cross-arms on ground or in the truck, and derricks for hoisting pre-assembled crossarms onto the poles for installation there. The payoff of these innovations is primarily labor saving and better coordination of operations at a faster pace. Figures 7.

[95-2415]

UDC 621.396.982.2

OPTIMAL THRESHOLD AND WEIGHT SORTING OF ELEVATION ANGLE READINGS UNDER  
CONDITIONS OF FADEOUTS OF A DIRECTED SIGNAL

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 (manuscript received, after  
completion, 9 Dec 83) pp 24-28

PER'KOV, V.V.

[Abstract] Threshold and weight processing of elevation angle signals is considered under conditions of signal fadeouts in background noise. The optimum threshold and the optimum weight function for signal sorting in the radio direction finder are determined, sorting on the basis of either of the two criteria being effective only in the case of fast deep fadeouts with appreciably different dispersions of readings. Calculations are made for fast uniform Rayleigh fadeouts. Both the optimum threshold and the optimum power-law exponent of the weight function are found not to depend either on the length of sampling time or on the signal-to-noise ratio, but only on the fadeout mode. The average dispersion of error in threshold sorting and the average dispersion of mean weighted value each have a soft minimum so that presetting of the threshold or of the weight factors, respectively, need not be very precise. Both average dispersions increase infinitely as the threshold or the power exponent, respectively, approach zero or infinity. The results are applicable to an useful for direction finding on the basis of maximum likelihood with circular scanning. Figures 2; references 8: 7 Russian, 1 Western (in Russian translation).

[96-2415]

UDC 621.391.244

MULTICHANNEL DIGITAL PROCESSING OF WIDEBAND SIGNALS

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 (manuscript received 11 Oct  
83) pp 3-8

MILYKH, M.M. and STRUCHEV, V.F.

[Abstract] The feasibility of processing wideband signals by discretization with high-speed narrow-band converters is examined, conventional analog-to-digital converters not being suitable for processing signals more than 20 MHz wide. Subdividing the entire frequency range into N narrow channels is proposed as an alternative, with discretization in each channel to be followed by reconstruction of signal readings from

readings in all those channels. For illustration, the signal is assumed to have a finite spectrum. Narrow channels are formed by means of quadrature conversion at the corresponding center frequencies with the aid of low-pass filters, whereupon analog-to-digital conversion is performed at the discretization frequency. The amplitude-frequency characteristics of these filters are trimmed and matched by means of a discrete Fourier transformation with the use of apertures such as Hemming or Kaiser apertures. The output signals from the filter array are subsequently processed by conventional two-dimensional methods for one-dimensional sequences. Figures 3; references 7: 4 Russian, 3 Western (2 in Russian translation).

[96-2415]

UDC 621.395.5.621.372.544

#### DIGITAL DETECTOR OF HARMONIC SIGNALS

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 (manuscript received, after completion, 27 Sep 83) pp 61-63

GOL'DENBERG, L.M., MATYUSHKIN B.D. and POLYAK, M.N.

[Abstract] A detector of harmonic signals is synthesized with an array of digital filters, harmonic signals at  $p$  definite different frequencies among  $s$  possible ones being sent through a communication channel over some period of time  $\Delta$  for service purposes. Each filter is followed by a threshold device deciding about the presence or absence of a sinusoidal signal. An array of two filters is considered for detection of signal  $\sin(n\omega_i T + \phi) = \sin\phi\cos(n\omega_i T) + \cos\phi\sin(n\omega_i T)$  ( $\phi$ -a priori unknown phase,  $T$ -discretization interval,  $(N-1)T$ -length of filtration interval,  $n = \Delta/T$  -number of input signal reading,  $i=1,2$  referring to the threshold devices), with filter 1 matched to signal  $\cos(n\omega_i T)$  and filter 2 matched to signal  $\sin(n\omega_i T)$ . The performance of this detector is evaluated, by simulation of the pulse response characteristics and the transfer functions of both filters, for  $n=N-1$  and the smallest  $N$  possible which will satisfy the equality  $\omega_i NT = 2\pi r_i$  ( $r_i$ -some integer). The detector is found to allow for some variations of amplitude and frequency in the input signal. Figures 3; references 3: 1 Russian, 2 Western (1 in Russian translation).

[96-2415]

UDC 621.396.62.019.4

OPTIMAL DISCRETE FILTRATION OF INTRICATE PHASE-KEYED SIGNALS

Moscow RADIOTEKHNIKA In Russian No 10, Oct 84 (manuscript received, after completion, 20 Jan 84) pp 55-58

TUZOV, G.I., GORSHKOV, V.V. and RUBTSOV, S.A.

[Abstract] Synthesis of an optimum discrete filter for arbitrarily intricate phase-keyed signals is shown, assuming that such signals arrive at the receiver in an additive mixture with Gaussian white noise. While both phase angle  $\theta(t)$  and time delay  $\tau(t)$  are described by stochastic equations,  $d\theta/dt = \omega - \omega_0$  and  $d\tau/dt = v - v_0$  ( $t$ -time,  $\omega_0$ -a constant frequency,  $v_0$ -a constant rate of change of time delay), the state vector  $X(t)$  is to be estimated from the a priori probabilistic equation  $X(t) = FX(t) + GW(t)$  ( $F$ -state matrix,  $G$ -perturbation matrix,  $W^T(t)$ -noise vector). The equations of optimal continuously discrete filtration are derived on the basis of the Markov nonlinear filtration theory, whereupon the covariational error matrix is calculated. The accuracy and the interference immunity of the corresponding processor structure under static and dynamic conditions depend, accordingly, on the behavior of the error matrix elements in time. The steady-state interference immunity of such an optimum discrete receiver is somewhat lower than that of the corresponding optimum analog one, the discretization process playing the major role in lowering it. Figures 2; references 7: 6 Russian, 1 Western (in Russian translation).

[96-2415]

UDC 621.396.23

ADAPTIVE REGULATION OF TRANSMITTER RADIATION POWER IN RADIO LINES DURING DELAYS OF CONTROL SIGNALS

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 pp 36-37

[Annotation of article No 324 field at Central Scientific and Technical Institute 'Informsvyaz', listing 3 bibliographic references]

ONYSHKO, A.G. and POSTYUSHKOV, V.P.

[Abstract] Adaptive power regulation is considered for transmitters in radio lines with signal fadeout. This requires availability of some extra power margin for compensating the decrease of reliability caused by delays of control signals. The algorithm for optimizing adaptive power regulation so as to ensure required reliability with minimum energy loss, or maximum efficiency with no decrease of reliability, is shown for a typical communication channel with log normal distribution of the transmission coefficient. Figures 1; references: 1 Russian.

[96-2415]

UDC 521.396.218

TRANSMISSION OF DIGITAL DATA OVER CHANNELS OF MOBILE URBAN COMMUNICATION SYSTEM

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 (manuscript received after abrangement, 11 Feb 84) pp 19-21

GURVITS, V.L. and CHVILEV, G.D.

[Abstract] Experimental data (J.L. Turin Proc. IEEE, Vol 69, No 3; 1981; H. Suzuki, IEEE Trans. COM-25, No 7, 1977) are used as the basis for a mathematical model of urban communication channels with moving objects. Signals arriving at the receiver along different paths are distinguished on the basis of some identifying parameter, usually the delay time, the entire range of this parameter being subdivided into nonoverlapping intervals so as to allow resolution of signals falling within adjacent intervals. Upon entering the receiver, signals are grouped into the various delay ranges depending on the location of the moving object. It is permissible and most expedient to assume that information is carried by binary symbols in a Markov relation and that the interference in each channel is independent of any other, with signal and channel parameters varying slowly enough for their accurate estimation. The probability of a signal appearing in more than one channel, a detection error, and the probability of no signal appearing in a channel both depend on the probability of a signal appearing in one. The algorithm of signal discrimination under these conditions is constructed accordingly, and the minimum number of channels is selected so as not to allow these two probabilities to exceed prescribed limits. Figures 2; references 5: 3 Russian, 2 Western.

[96-2415]

COMPONENTS, HYBRIDS AND MANUFACTURING TECHNOLOGY

UDC 621.365:621.373

TRAINING OF ELECTROTHERMAL SPECIALISTS AT LENINGRAD INSTITUTE OF ELECTRICAL ENGINEERING IMENI V.I. UL'YANOV (LENIN)

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 9, Sep 84 (manuscript received 20 Sep 83) pp 11-13

DOROFEEV, GENNADIY IVANOVICH, candidate of technical sciences, docent, Leningrad Institute of Electrical Engineering

[Abstract] After study, development and design of high-frequency induction crucible furnaces for steelmaking was transferred in 1935 from the Central Radio-Frequency Laboratory under Professor V. P. Vologdin to the Leningrad Institute of Electrical Engineering, it was found necessary to organize a special study course on the subject of electrothermal equipment and its automation. The pilot group of 8 students in 1940 has grown into a regular class from which 980 engineering specialists in high-frequency technology and electrothermal facilities have been graduated over the subsequent 36 years. Then in 1982 this course was merged with the course in power supplies for electrothermal and physicotechnical facilities, the latter having been organized in 1972. The joint department graduates now approximately 70 engineers annually for work in this specialty. A third discipline has also been added in the meantime, namely plasma and electron-beam facilities. The teaching staff of 19 includes 3 professors and 12 docents. The high-frequency laboratory of the department, in existence since 1965, employs a staff of 50 and conducts scientific research on an annual budget of about 40,000 rubles. Specific areas of this research are: induction heating facilities, including 50 Hz furnaces, induction melting of refractory materials in cold crucibles, automatic control of welding processes, electrical equipment for laser and electron-beam facilities, and thyristor-type static frequency converters. Theoretical research includes computer-aided design and simulation. Outstanding contributions made by students are published in the IZVESTIYA LENINGRADSKOGO ELEKTROTEKHNICHESKOGO INSTITUTA.

[77-2415]

UDC 621.365.5:533.915.072

SIMULATION OF THERMAL AND ELECTROMAGNETIC PROCESSES IN INDUCTION PLASMATRONS

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in  
Russian No 9, Sep 84 (manuscript received 20 Sep 83) pp 13-21

POLEVODOV, BORIS SERGEYEVICH, candidate of technical sciences, docent,  
DEMIDOVICH, VIKTOR BOLESLAVOVICH, candidate of technical sciences, senior  
scientific associate, and SKVORTSOV, YURIY ALEKSEYEVICH, engineer,  
Leningrad Institute of Electrical Engineering

[Abstract] In the most general model of a plasma its kinetic description is based on statistics of a multiparticle system, which can be treated as a liquid with temperature-dependent thermal conductivity, electrical conductivity, and viscosity. The flow of such a liquid in an induction plasmatron is described accordingly, in the approximation of an equilibrium plasma. Simulation of the plasmatron performance involves calculation of the heat and mass transfer, heat sources and ponderomotive forces being obtained from the solution to the corresponding Maxwell equations, and calculation of the electromagnetic field. The electromagnetic problem can be solved by two basic methods, taking into consideration that the intricate current density distribution and the nonstationary boundaries of the conduction region are not a priori known. The first method is based on long-range action and Ampere's law. The corresponding Fredholm integral equations of the second kind need to be solved for the conduction region only. The second method is based on short-range action and mathematical description by a second-order differential equation, solvable by the algorithm of finite differences. This allows subdividing a region into a large number of finite elements. Both methods have been combined so that the advantage of each is utilized in the proper sequence. The complete model of a plasmatron is based on the given initial temperature field and thermophysical properties of the gas. The electromagnetic problem is solved first and, after the distribution of power sources has been determined from that solution, the thermal problem is solved next. The inductor-plasma system is assumed to be a cylindrical axisymmetric one, with the electric field distribution in a thin layer around the load periphery serving as the boundary condition for the internal electromagnetic problem, while the electric field distribution everywhere else in the load region is assumed to be known. The authors thank A.S. Vasil'yev, doctor of technical sciences, A.Ye. Slukhotskiy, doctor of technical sciences, and S.G. Gurevich, candidate of technical sciences for discussion and helpful suggestions, as well as I. I. Iokhina and Ya.G. Baranovskaya, both scientific associates, for assistance in writing computer programs. Figures 7; references 12: 5 Russian, 7 Western (3 in Russian translation).

[77-2415]

UDC 621.36:621.7/9

REDUCING ELECTRIC POWER LOSSES IN DISCHARGE CHAMBER OF INDUCTION PLASMATRON

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 9, Sep 84 (manuscript received 20 Sep 83) pp 21-27

BORISENKOV, VIKTOR IVANOVICH, junior scientific associate, DRESVIN, SERGEY VYACHESLAVOVICH, doctor of technical sciences, professor, and KUZ'MIN, LEV ALEKSANDROVICH, candidate of technical sciences, senior scientific associate, Leningrad Polytechnic Institute

[Abstract] The main advantage of induction plasmatrons is the absence of electrode erosion products in the cold plasma, but their drawback is a high Joule-effect power loss in the metal wall of the discharge chamber. At operating frequencies of 5.28, 1.76, 0.44 MHz the power lost on heating the metal wall constitutes, respectively, 1-1.5%, 3-5%, 10-12% of the total input power. An experimental study of this power loss was made, therefore, for the purpose of finding ways to reduce it. The cylindrical wall was segmented into eight identical longitudinal panels of four different constructions: 1) hollow (duct) all-copper; 2) hollow (duct) copper slit lengthwise on the outside for insertion of a dielectric strip; 3) solid (plate) all-copper; 4) solid (plate) made of 12Kh18N10T stainless steel. Reducing the wall thickness cannot be carried far enough, because the wall must withstand the pressure of cooling water pumped through the chamber and a thin wall would require a high-strength material. Calorimetric measurements were made in the frequency range of rotating alternators and thyristor converters. Calculations were made on the basis of the electromagnetic models representing each kind of wall panel, disregarding the nonuniformity of the inductor field as well as the interaction of inductor current and induced wall current. The results of measurements and calculations agree fairly well and indicate that at 8 kHz splitting the copper decreases the power loss to about half and replacing copper plate with steel plate of the same thickness decreases the power loss to about one sixth. The steel plate can be made much thinner, however, so that a decrease of power loss by a factor of at least 26 and up to 300 becomes feasible for 5-10 MW plasmatrons with discharge chambers operating at 2-10 kHz. Figures 3; tables 2; references 5 Russian.

[77-2415]

UDC 621.365.9:533.9

## CHARACTERISTICS OF MULTIARC PLASMA DEVICES

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 9, Sep 84 (manuscript received 20 Sep 83) pp 27-33

KLUBNIKIN, VALERIY STEPANOVICH, candidate of technical sciences, senior scientific associate, Leningrad Polytechnic Institute, and SMIRNOV, BENEDIKT GIGGOR'YEVICH, candidate of technical sciences, senior instructor, Mari Polytechnic Institute

[Abstract] Multiarc plasma devices such as plasmatrons operate with lower arc currents than single-arc counterparts, which not only contributes to a higher efficiency but also extends the life of electrodes. Typically, reduction of the arc current for producing an air plasma from 400 A to 100 A or further to 50 A lengthens the life of zirconium electrodes from 24 h to 400 h and 1600 h, respectively. The electric arcs can be connected in series or in parallel. A series connection, used for deposition processes, features high arcing stability but requires special mixing chambers for prevention of mutual arc shunting. A parallel connection eliminates this drawback but limits the arcing stability, the latter decreasing as the number of arcs in parallel increases. A third possibility is a multiarc device with separate voltage supplies and a single common control system. The performance of any multiarc plasma device is determined by its current-voltage characteristic. For determining the optimum operating mode, not only the dependence of the arc voltage on the arc current but also its dependence on the arc length, the channel diameter, the gas flow rate, and the gas pressure have been evaluated. Calculations are based on semiempirical and dimensional analysis of experimental data from about 200 measurements over wide ranges of variable parameters for discharge in argon. Two important parameters characterizing the current-voltage curve have been obtained as a result, namely the differential arc resistance and the critical arc current corresponding to zero differential arc resistance, as well as the longitudinal profile of the electric field intensity. The plasmatron efficiency is calculated, as an integral quantity and as a local one, from the energy equation for a discharge plasma in thermal equilibrium. Convective and radiative heat losses are accounted for separately according to appropriate semiempirical relations. A maximum local efficiency of 80-95% is found to be feasible, but ballast resistors needed for stability in molecular gases (air, N<sub>2</sub>, H<sub>2</sub>) will lower it appreciably. Figures 1; references 10: 9 Russian, 1 Western.

[77-2415]

UDC 621.365.5

COMPUTER SIMULATION OF EQUIPMENT AND PROCESSES INVOLVED IN HIGH-FREQUENCY HEATING OF DIELECTRICS

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 9, Sep 84 (manuscript received 20 Sep 83) pp 38-46

BEZMENOV, FELIKS VASIL'YEVICH, candidate of technical sciences, director, GUREVICH, SERGEY GRIGOR'YEVICH, candidate of technical sciences, laboratory manager, and DEKSTER, NATAL'YA DAVYDOVNA, junior scientific associate, All-Union Scientific Research Institute of High-Frequency Currents imeni V.P. Vologdin

[Abstract] Computer software for simulation of high-frequency electric heating of dielectric materials has been developed at the All-Union Scientific-Research Institute of High-Frequency Currents with assistance from the Industrial High-Frequency Electrical Engineering Laboratory at the Leningrad Institute of Electrical Engineering. It consists of several program modules for process analysis and equipment design and performance calculations, different modules for different types of heating processes in different applications. In a short-duration heating process the electrostatic or electromagnetic field determines the heat sources and the latter determine the temperature field, inasmuch as heat conduction can be disregarded, so that in this case only the electrostatic or electromagnetic field needs to be calculated. In the case of a long-duration heating process it is necessary to solve both the electrical problem and the thermal problem. The electric field is calculated from the equation of the potential field or from the system of Maxwell field equations, depending on the ratio of wavelength to capacitor dimension. The equation of the potential field is solved by the method of finite differences for simple configurations or by the method of finite elements for intricate configurations, the latter method being equivalent to minimization of the field functional in the variational form of the problem. The equations of one- or two-dimensional wave fields are solved by direct methods. The temperature field is calculated from the nonlinear equation of heat conduction by the method of reversing directions, which also involves solving the Stefan problem when the material changes its state of aggregation in the process. The method of smoothing is then used, with the latent assumed to be released within a certain temperature range. An explicit scheme is used for this particular temperature range, while an explicit scheme is used for all other intervals so as to save computer time by increasing the step. Typical applications for high-frequency electric heating are welding of solid dielectrics such as micarta sheet or polyvinyl chloride and drying of dielectric powders such as magnesium fluoride. Capacitor design and performance calculations for these processes have been made using the appropriate computer programs developed for that purpose. The authors thank A. S. Vasil'yev, doctor of technical sciences, and N.A. Pavlov, candidate of technical sciences, for helpful suggestions, also M.G. Firsova and G. S. Knyazhevskaya, scientific associates, for discussing the results. Figures 6; references 14: 12 Russian, 2 Western (in Russian translation). [77-2415]

UDC 621.365.6:666.1.031.3

## GLASS FOUNDRY IN COLD-Crucible INDUCTION FURNACE

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 9, Sep 84 (manuscript received 20 Sep 83) pp 64-69

NEZHENTSEV, VADIM VASIL'YEVICH, junior scientific associate, PETROV, YURIY BORISOVICH, candidate of technical sciences, docent, and LOPUKH, DMITRIY BORISOVICH, engineer, Leningrad Institute of Electrical Engineering, ZHILIN, ALEKSANDR ALEKSANDROVICH, candidate of chemical sciences, senior scientific associate, State Institute of Optics imeni S.I. Vavilov

[Abstract] Problems of glass founding in cold-crucible induction furnaces are examined, most of them attributable to a lagging state of the art on both theoretical and practical levels. Two basic methods are considered, namely founding in a water-cooled copper or aluminum crucible or founding in a laterally water-cooled all-quartz crucible standing on a segmented metal base. The latter type of crucible is more reliable and used for casting, because glass is not in contact with metal and will not be contaminated, while the former types of crucible is used for producing bulk glass. Design of a furnace begins with selection of the temperature field for glass fusion, if homogeneity of the product rather than maximum productivity or maximum reliability is regarded as the overriding requirement. Forces stirring may be necessary for avoidance of overheating and thus prevent flaws, depending on the viscosity of the glass. Stability of the process requires that the power developed in the melt balance the total heat loss, only loss by convection and radiation being significant, while its derivative with respect to temperature  $\partial P_D / \partial T$  may never be larger than that of the heat loss power  $\partial P_L / T$ . Such a balance is attainable at any temperature above 1000°C, inasmuch as the heat loss power increases monotonically with rising temperature, proportionally to the temperature squared over the 1000-1500°C range and to the temperature cubed over the 1500-2000°C range, while the developed power increases at a decreasing rate till it peaks at some temperature above the operating point and then decreases. The next step is to determine the optimum crucible and inductor geometry, with a quasi-uniform temperature field as a criterion. One critical parameter here is the clearance between crucible and inductor. As this clearance is made smaller, the power factor of the inductor circuit increases exponentially and the inductor voltage can be lowered for more reliable operation. There are two factors which determine what the smallest clearance can be, namely the dielectric strength of air and the attenuation in the anode circuit. The final crucible dimensions (diameter and height), inductor dimension (diameter), and the clearance must be checked for the developed power, which is done according to an empirical relation based on covering convective and radiative heat losses. Figures 5; references: 2 Russian.

[77-2415]

UDC 621.365.5

COMPUTER-AIDED DESIGN OF INDUCTION HEATERS FOR STEEL BLANKS WITH USE OF  
DIGITAL MODELS

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in  
Russian No 9, Sep 84 (manuscript received 20 Sep 83) pp 52-59

NEMKOV, VALENTIN SERGEYEVICH, doctor of technical sciences, professor,  
Leningrad Institute of Electrical Engineering, and KAZ'MIN, VLADIMIR  
YEFIMOVICH, engineer, junior scientific associate, All-Union Scientific-  
Research Institute of High-Frequency Currents imeni V.P. Vologdin

[Abstract] Construction and the use of digital models for computer-aided  
design of special-purpose induction heaters are shown, models more precise  
and versatile than a known model of a semicontinuous induction heater. For  
heating of steel blanks in a continuous process, linear array of standard  
heater units consisting of capacitors and 1-4 inductor segments with a cool-  
ing system along the conveyor belt are generally used. An iterative design  
with performance analysis after each iteration involves solution of two  
coupled problems. Both the electrical one and the thermal one are non-  
linear, for a system which occupies a large space. Most expediently the  
electrical problem for the region outside a steel blank is solved by the  
integral method and the problem for the electromagnetic field and the tempera-  
ture field inside a steel blank is solved by combining the analytical method  
with the method of finite differences. The procedure is demonstrated on a  
transfer heater with a uniform electromagnetic field inside a steel blank,  
taking into account the skin effect during the initial "cold" stage, a non-  
magnetic surface layer during the intermediate stage, and complete loss of  
magnetic properties during the final "hot" stage, while disregarding the  
negligible axial heat flow throughout the process. An analytical solution  
for the initial stage saves computer time by reducing the number of iterations  
in the subsequent numerical solution for the later stages. Use of a finite-  
difference scheme for solution of the internal electrical and thermal problems  
permits inclusion of the temperature-dependence of the thermophysical, electri-  
cal and magnetic properties. As a typical example the design is considered  
of an induction heater for an INTI-750/1 steel pipe manufacturing facility  
which, according to specifications, requires three 630 kW heater units per  
line. Calculations were made on a YeS-1032 computer, using the SUGRAN program  
for the external electrical problem. Figures 4; references: 8 Russian.  
[77-2415]

TRANSISTOR-TRANSISTOR LOGIC MICROCIRCUIT TESTER

Moscow RADIO in Russian No 8, Aug 84 pp 45-46

ZAL'TSMAN, Yu., Alma-Ata

[Abstract] Digital microcircuits currently in use need to be tested before  
final installation. The present article describes a tester consisting of a  
control code former and comparison and indication devices. The importance of  
limiting the duration of load on the HLL light diode to prevent burn-out is  
stressed. With a frequency coefficient of 1024, all states are indexed about  
1000 times per second. Technical features of the tester are diagrammed and  
described. Correct switch-on of microcircuits and the variety of applications  
for the testers to a number of microcircuits with varying input and output  
set-ups are summarized. Figures 2; tables 1.  
[78-12131]

COMPUTERS

UDC 621.3.053

REDUNDANCY OF CODES FOR DETECTION AND CORRECTION OF UNIDIRECTIONAL ERRORS

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 (manuscript received 28 Oct 83) pp 63-65

BORODIN, G.A., STOLYAROV, A.K. and IVANOV, V.A.

[Abstract] The necessary redundancy of codes for detection and correction of errors in programmable modular semiconductor-microcircuit memories is evaluated, in terms of the lower bound for the number of control digits in such a code. Considering that all errors of failure in such a memory are unidirectional, its cells switching together either to the "0" state or to the "1" state, this redundancy analysis is based on two theorems pertaining to the error detection and correction capability of a code depending on properties such as disorderedness of any of its component word-vector pair. With the aid of these two theorems six other ones are validated which pertain to the buildup of a word-vector pair and to the number of control digits a code must contain, depending on the word-vector length and on the error length. References 8: 4 Russian, 4 Western.

[96-2415]

UDC 621.326:621.387

PROGRAM FOR CONTROLLING ELECTRICAL MEASURING CONTACT INSTRUMENT ON GLOW-DISCHARGE INDICATOR PANEL

Moscow RADIOTEKHNIKA In Russian No 10, Oct 84 pp 70-71

[Annotation of article No 397 field at Central Scientific and Technical Institute 'Informsvyaz', listing 2 bibliographic references]

STEPANOV, V.N.

[Abstract] A program to be entered in the read-only memory of a microprocessor is now available for controlling the display of alphanumeric and symbolic data on a panel consisting of 8x5 IMG-3-01 indicator modules. The microprocessor must have the capability to receive data in the MTK-2

sequential code and in the KOI-7 parallel code, typically from a telegraph set and from a computer terminal, respectively, to store data coming from each in separate buffers of the direct-access memory, and to display as well as to erase them. The program includes five subroutines: 1) processing of interrupts from telegraph OPRTA and from computer terminal OPRAP; 2) control subroutine; 3) display of memory contents from buffer assigned to telegraph OTTA and from buffer assigned to computer terminal OTAP; 4) clearing of contents from either buffer SBTA and SBAP; 5) clearing the display panel. The program occupies 1814 bytes in the read-only memory and 6320 bytes in the direct-access memory.

[96-2415]

ELECTRICAL INSULATION

UDC 538.56

DETERMINING DISTRIBUTION OF COMPLEX DIELECTRIC PERMITTIVITY OVER CYLINDRICAL BODY OF INTRICATE CROSS SECTION FROM ELECTROMAGNETIC FIELD MEASUREMENT

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 10, Oct 84 (manuscript received, after completion, 2 Jun 82) pp 15-20

STADNIK, IVAN PETROVICH, candidate of technical sciences, docent, and GORSKAYA, IRINA YUR'YEVNA, junior scientific associate, Simferopol State University; KULIKOV, SERGEY PAVLOVICH, candidate of physico-mathematical sciences, assistant, Moscow Institute of Radio Engineering, Electronics and Automatics

[Abstract] A long cylinder of any given intricate cross section, with a dielectric permittivity and an electrical conductivity independent of the axial coordinate, is placed in the electromagnetic field of a monochromatic wave with the generatrix parallel to the electric field vector. The distribution of dielectric permittivity over cross sections of this cylinder is calculated from readings of the field components at points within a cross section. The first step of the algorithm is calculating the axial component of current density as the sum of density of the conduction current and the axial component of the polarization vector, the latter multiplied by the frequency. The second step of the algorithm is calculating the resultant internal electric field as the sum of the primary electric field and the electric field induced by the cylinder current of already known density. The third and last step of the algorithm is calculating the dielectric permittivity at any given point from the already known current density and the primary electric field. The current density needed for this procedure is determined from a system of algebraic equations describing its distribution, this system being solved by the interaction method. The resultant electric field needed for this procedure is obtained by adding to the primary electric field the electric field induced by currents in circular cylinders around given points in a cross section. The algorithm was verified by solving the reverse problem of diffraction for an electromagnetic wave and a cylinder with known permittivity distribution, with the cylinder subdivided into coaxial layers. Numerical verification was done for circular cylinders and square "cylinders" with zero electrical conductivity in the field of electromagnetic waves of various wavelengths within the 0.1-3 m range. No physical experiment was performed for verification. Figures 6; tables 1; references: 1 Russian.

[100-2415]

ELECTROMAGNETIC COMPATIBILITY

UDC 621.396.67.01

ALGORITHM FOR STATISTICAL SIMULATION OF ELECTROMAGNETIC COMPATIBILITY  
CHARACTERISTICS OF HIGH-FREQUENCY TRANSMISSION CHANNELS IN RADIOPHYSICAL  
FACILITIES

Moscow RADIOTEKHNIKA in Russian No 10, Oct 84 (manuscript received, after  
completion, 15 Nov 83) pp 33-35

IL'IN, Ye.M. and MINTS, S.V.

[Abstract] Considering that electromagnetic compatibility of radio-electronic equipment and its dependence on that of individual components are important criteria for the design and optimization of high-frequency transmission channels as well as for selecting their mode of operation, a statistical mathematical model is proposed for describing the spectral characteristics of such channels. This model assumes linear interaction of incoming parasitic signal components with the useful signal component in a nonlinear input amplifier. It also assumes that the spectral characteristics of individual equipment components are noncorrelated. The algorithm of statistical simulation and subsequent optimization on this basis consists of four successive steps: 1) analysis of equipment performance requirements, including signal characteristics and device characteristics, for establishment of essential energy and electromagnetic compatibility indicators; 2) structural synthesis of channel and particularization of its microwave components; 3) analysis of channel structure on the basis of the statistical model for feasibility of adapting electromagnetic compatibility of microwave devices to electromagnetic compatibility of high-frequency channel; and 4) analysis of statistical model, followed by optimization of channel components including microwave devices. For illustration, the results of such a statistical simulation are shown for an amplifier network with a TWT-diode-amplitron-diode channel. Figures 2; tables 1; references 3: 2 Russian, 1 Western (in Russian translation).

[96-2415]

INDUSTRIAL ELECTRONICS AND CONTROL INSTRUMENTATION

UDC 62-83:621.313.333

CONTROL OF NONLINEAR OBJECTS

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA  
in Russian No 10, Oct 84 (manuscript received 11 May 82) pp 68-73

IL'IN, OLEG PAVLOVICH, candidate of technical sciences, docent, and  
PRIMSHITS, PETR PAVLOVICH, candidate of technical sciences, docent,  
Belorussian Polytechnic Institute

[Abstract] A method of synthesizing automatic control for nonlinear objects is proposed which more readily yields the necessary dynamic characteristics than does Lyapunov's second method with reduction of the object to an asymptotically stable one. A mathematical model is considered which describes a nonlinear object by nonlinear equations of state  $X=AX+F(X)+U$  ( $X$ -state vector,  $U$ -control vector,  $A$  and  $F$ -matrices of dimensionalities depending on that of vector  $X$ ). The necessary dynamic performance will be ensured by a linear system describable by the normalized equations of state  $X=CX+BU_0$  ( $C$ -matrix of dimensionality depending on that of vector  $X$  and with coefficients determining the appropriate transient response). Synthesis of the control involves finding the equation  $U=U(X,A,C,B,U_0)$  which will make the nonlinear system behave like the linear one. This requires that the components of the control act at various points of the object and that the effect of negative feedback, except at the first point, be compensated. Nonlinearity composition can then be added to the main control and the feedback compensation. The algorithm of this method of synthesis has been verified by computer simulation and is demonstrated here on the control for an object describable by the equations of state  $\dot{x}_1=x_1x_2+x_2=F_1+x_2$ ;  $\dot{x}_2=-x_1-x_2$ ;  $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} x_1x_2 \\ 0 \end{bmatrix}$ . Figures 4; references: 2 Russian.

[100-2415]

UDC 62-50

## SYNTHESIS OF DIGITAL CONTROL FOR OBJECT WITH LAG

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA  
in Russian No 10, Oct 84 (manuscript received 13 Jan 82) pp 58-64

ROTACH, VITALITY YAKOVLEVICH, doctor of technical sciences, professor,  
Moscow Power Engineering Institute, and GAYDUK, ANATOLIY ROMANOVICH,  
candidate of technical sciences, docent, Taganrog Radio Engineering  
Institute

[Abstract] An algorithm of microprocessor-aided digital control is constructed for a linear object with lag. The object is assumed to be continuous, thus comprising a pulse filter, its interaction with the control device occurring through appropriate analog-to-code and code-to-analog converters. Level quantization is negligible, assuming a sufficiently large word length in the computing device. The discretization period  $T$  is selected so as to make the lag time  $\tau_0 = (\mu_0 - 1)T + \xi T$  ( $\mu_0$ -positive integer,  $\xi = 0.5$ ) and allow it to vary within the  $(\mu_0 - 1)T < \tau_0 < \mu_0 T$  range. The corresponding equation of state and action in discrete Laplace transforms is solved for zero initial conditions, upon its conversion to a difference equation with all constant numerical polynomial coefficients evaluated and the numbers of coefficients established in the synthesis process. A theorem pertaining to the conditions for existence and uniqueness of a solution is formulated, and proved, in terms of two bounds for numbers of coefficients in the denominator and the numerator relative to the order of the open-loop system and  $\mu_0$ . The order of the closed-loop system is established on this basis, as are relations necessary for obtaining the desired response characteristic. The algorithm is demonstrated on controlling the first-order object with the transfer function  $W(s) = \tilde{y}/\tilde{u} = K \frac{T_2 s + 1}{T_1 s + 1} e^{-\tau_0 s}$  ( $\tilde{y}$ -Laplace transform of continuous regulated variable,  $\tilde{u}$ -Laplace transform of continuous control variable,  $K$ -transfer ratio of object together with analog-to-digital and digital-to-analog converters), lag time  $\tau_0 = 1.5T$  corresponding to  $\mu_0 = 2$  and  $\xi = 0.5$  ( $T$ -period of one control computation), and  $T_1 = T_2$ . Tables 1; references: 3 Russian. [100-2415]

MAGNETICS

UDC 622.778.3

MAGNETIC FIELD IN MAIN GAP OF SEPARATOR

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 10, Oct 84 (manuscript received, after completion, 21 Sep 83) pp 20-23

KARTASHYAN, VAGINAK ONIKOVICH, candidate of technical sciences, docent, FADEYEV, VLADIMIR IVANOVICH, candidate of technical sciences, docent, and SPIVAK, ALEKSANDR NIKOLAYEVICH, junior scientific associate, Voroshilovgrad Mechanical Engineering Institute

[Abstract] High magnetic flux density in the main gap of a metallurgical separator is achieved by shunting the active zone with a ferromagnetic chute, a specially profiled pole pieces producing the necessary non-uniformity of the magnetic field in that gap. A method is proposed here because no accurate engineering method is available for calculating the magnetic field in such an intricate structure. One symmetric pole tooth is singled out for calculations, and all pole pieces are assumed to be saturated so that the magnetic permeability of the steel can be taken as  $\mu = \infty$ . The boundary conditions are zero flux gradient under the pole tip at the center, where the gap is narrowest, and zero tangential field intensity component at the steel-air interface. Calculations are made by the method of conformal mapping, with use of the Schwarz-Christoffel transformation, and subsequent evaluation of the corresponding Euler (beta function) integrals. The results of this theoretical procedure have been found to agree within 7% with a physical model. Figures 3; tables 1; references 5: 3 Russian, 2 Western (in Russian translation). [100-2415]

UDC 538.245

BEHAVIOR OF SMALL FERROMAGNETIC PARTICLES IN TRAVELING MAGNETIC FIELD

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 10, Oct 84 (manuscript data not given) pp 23-26

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[Abstract] Forces and moments acting on a magnetizable body in a traveling magnetic field are calculated for a body with dimensions much smaller than the wavelength of the magnetic field. A particle of given linear dimension is assumed not to have a constant magnetic moment. The material of a particle is characterized by its magnetic permeability and electrical conductivity. An analysis of the problem confirms the hypothesis that rotation plays a major role in the behavior of small particles and explains the experimentally established fact that a small particle rolls on a plane, without sliding, when the surface is perfectly rough, in a direction opposite to the direction in which the magnetic field travels and thus to the direction in which a large flat conductor moves. Calculations are based on the magnetohydrodynamic equations for a quasi-steady magnetic field, also taking into account the induced Foucault eddy currents. The results are applicable to transport of ferrofluids and to such metallurgical devices as separators. Figures 1; references 8: 7 Russian, 1 Western.

[100-2415]

POWER ENGINEERING

UDC 621.315.1.027.8.016

INCREASING LOAD CAPACITY OF 1150 kV A.C. ELECTRIC TRANSMISSION LINE BY MEANS OF REACTIVE-POWER SOURCES

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 84 pp 41-45

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[Abstract] One method of raising the load capacity of superhigh-voltage a.c. electric transmission lines in an economical manner and at the same time ensuring adequate static as well as dynamic stability in the system is compensation of the reactive power. The underlying principle is demonstrated on a single-circuit 1150 kV line running parallel to 500 kV and 220 kV lines. For the purpose of analysis and estimation, it is assumed that the voltage phase can shift by 200° over a 3000 km distance. Installation of compensating reactors at intermediate points contributes appreciably to voltage maintenance not only during steady operation but also during slow and fast changes caused by switching, faults, and various transient processes. Calculations are made for several power levels from 3000 MW to 7200 MW, a full swing over this range requiring a total of 1800 MVAR on the input side or -1800 MVAR on the output side. A comparative performance and cost evaluation of synchronous rotating compensators and static thyristor compensators indicates a preference for combining both. Synchronous rotating compensators have four basic drawbacks: copper and iron losses, need for over-voltage limiters, need for constant attendance by service crew, and inability to provide individual phase control. Static thyristor compensators do not have these drawbacks and, moreover, are faster acting. Their capacity is limited and may be inadequate, however, so that either synchronous rotating compensators or capacitor banks and reactors must be added, with the most appropriate connection to autotransformers or transformers. Another advantage of such an arrangement is the possibility of stepwise cut-in of reactive-power compensation. The cost increases steeply above the 6000 MW power level, but can be reduced by spreading the phases or otherwise decreasing the resultant inductive impedance component and increasing the resultant capacitive admittance component. Figures 2; references: 4 Russian.

[92-2415]

UDC 621.315.2.027.4.019.3

RELIABILITY OF CABLE TRANSMISSION LINES FOR VOLTAGES UP TO 1000 V

Moscow ELEKTRICHESTVO in Russian No 9, Sep 84 pp 72-73

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[Abstract] In the Leningrad regional power system, 0.4 kV cable lines constitute 27% of all cable lines in the 10 kV class and they distribute 35% of all generated energy, their rate of scheduled expansion being 3% annually. There are insufficient data available on their reliability, however, and therefore an analysis of their failure statistics was made covering the 1970-80 period and 1983 with a total of 30,000 km·years. All faults which have occurred are grouped according to location, the four categories being (in the order of decreasing number of faults) length of cable, connecting sleeves, terminal dividers, branching sleeves, and according to age of lines. While faults along cable segments increased over the years from 49% during 1970-75 to 64% in 1983, those in the other locations remained roughly at the same average percentage level. Most faults, moreover, occurred in lines 30-40 years old: typically 20 faults per 100 km annually. The main cause of faults was mechanical damage incurred during installation, but some of that damage can be traced to artillery activity during the Second World War. Repairs and overhaul have been scheduled accordingly and 1100 man·hours were assigned to this task in 1983. Overall experience indicates that lead sheaths are adequate as a neutral conductor and that armored cables require additional protection with brick lining in ground with heavy water activity, even under high-grade asphalt pavement. Tables 1.

[92-2415]

ELECTRIC POWER SUPPLIES FOR DEPOTS

Moscow AVTOMATIKA, TELEMEKHANIKA I SVYAZ' in Russian No 8, Aug 84 p 24

IVLEV, A.B.

[Abstract] The Central Institute of Standard Designs has added "Electric Power Supplies for Standard Depots" to Part 2 of its "Standard Designs of Enterprises, Buildings and Facilities" catalog. The power supplies are designed for handling maximum occupancy of depots and include storage batteries capable of energizing depot equipment for two hours during emergency. The documentation 501-05.42.84 consists of three pamphlets: for type II depots with underground level, for type III depots with brick walls, and for type IV depots with brick walls. In the meantime, the Lvov Bus Manufacturing Plant is now producing depot equipment used on two-cable trunk lines with K-60p high-voltage transmission lines.

[95-2415]

UDC 621.311.6.027.3

POWER SUPPLIES WITH VOLTAGE MULTIPLIERS FOR ELECTRON-BEAM TECHNOLOGY

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 9, Sep 84 (manuscript received 20 Sep 83) pp 113-117

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[Abstract] Generators of accelerating voltage used in electron-beam equipment employed for welding, soldering, melting, or machining must feature small voltage fluctuations at a high level of the output potential, a stiff output characteristic, a high power factor, and excellent dynamic characteristics for automatic control. These features are realized by seven voltage multiplier circuits: 1) 1-phase 1-half-period; 2) 1-phase 2-half-periods; 3) 1-phase 2-half-periods cyclic; 4) 2-phase symmetric; 5) 3-phase 1-half-period; 6) 3-phase bridge 2-half-periods; 7) 3-phase 2-half-periods cyclic. The 3-phase 2-half-periods cyclic circuit is most intricate and no data on its performance characteristics are available. They are therefore analyzed here, starting with the system of logic equations which describe the circuit from the input side. The rectified output voltage is found by solving the system of difference equations describing both Kirchhoff's laws with the aid of the discrete Laplace transformation. Also calculated are the internal resistance, proportional to a third-degree polynomial in the number of stages, as well as the voltage ripple factor, the output current pulses into a high-resistance load, and the power factor. The results are compared with analogous expressions for the six other voltage multiplier circuits, those circuits having already been analyzed. Figures 1; tables 1; references: 3 Russian.

[77-2415]

UDC 656.254.15

## IMPROVING AUTOMATICALLY SWITCHED RAILROAD TELEPHONE NETWORK

Moscow AVTOMATIKA, TELEMEKHANIKA I SVYAZ' in Russian No 8, Aug 84 pp 25-27

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[Abstract] Automatically switched railroad telephone networks require continuous improvement and expansion. The main problems are addition of channels for hookup of more numbers, improving the quality of service, and the addition of new services such as automatic railroad traffic control. A survey of the present status in the Belorussian railroad system has yielded data on the capacity and the performance of its automatically switched telephone network. These data were evaluated in terms of channel loading parameter  $y = nct$  ( $n$ - number of load sources,  $c$ - average number of calls from one source per unit of time,  $t$ - average duration of one channel occupancy), duration of the heaviest load, and probability of successful connection with a "busy" number. The results, processed in the form of histograms serve as basis for strategizing maintenance and hookup operations. They suggest that all these operations be performed during the slack periods and that countermeasures be introduced in order to reduce the percentage of connections missed during peak periods from the present high 62% to the All-Union 5-20% level. It should not require more than an average 2.4 trials for making a connection, the actual number of trials depending on the caller's urgency and persistence as well as on the time between successive "busy" states of the called number. Implementation of these recommendations and multichannel interlocking with automatic inspection with equipment and in accordance with procedures successfully used on the L'vov railroad line have greatly improved the automatically switched telephone network on this line. Figures 6; tables 1.

[95-2415]

## CAUSE OF MALFUNCTIONING OF 42RTM-A2-ChM RADIO STATION HAS BEEN FOUND

Moscow AVTOMATIKA, TELEMEKHANIKA I SVYAZ' in Russian No 8, Aug 84 p 27

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[Abstract] Malfunctioning of the 42RTM-A2-ChM FM radio station in cabin 2 of electric locomotives built at the Tbilisi plant was found to occur upon pressing the microtelephone touch button, i.e., the pilot lamp on the control panel in that cabin will go out, indicating automatic transfer to the control panel in cabin 1. No such malfunctioning was found to occur in electric locomotives built in the Novocherkassk plant. The cause of this

malfunctioning has been found to lie in the shielding braid of the antenna cable, which at one end is insulated from the high-frequency connector case by a rubber gasket. The braid therefore acts as a radiator or additional antenna and induces an emf in the base-emitter circuit in the transistor switch T3 on the control panel in whichever cabin the microtelephone stands, so that the control panel in the other cabin is switched on. In order to avoid this, the antenna cable should not be bundled together with wiring to the control panels but be laid separately as it is in the Novocherkassk electric locomotives.

[95-2415]

#### MECHANICAL AND CLIMATIC CONSTRAINTS ON RADIO EQUIPMENT USED IN RAILROAD TRANSPORTATION

Moscow AVTOMATIKA, TELEMEKHANIKA I SVYAZ' in Russian No 8, Aug 84 pp 43-47

VAVANOV, Yu.V., candidate of technical sciences, laboratory manager, and DAGAYEVA, N.Kh., senior scientific associate, All-Union Scientific Research Institute of Railroad Transportation Engineers

[Abstract] Several All-Union State Standards exist that specify mechanical and environmental hazards which railroad radio equipment must withstand. Such equipment is classified into nine groups, stationary and mobile equipment operating indoors or outdoors in various climates, above ground or underground, hand portable or transportable by other means. Special standards have been written for railroad automation and remote control equipment, for machines and instruments as well as other railroad radio hardware, for general electrical engineering equipment, for electron and electrical devices, for radio equipment installed in locomotives, trolleys, or buses, for mobile ground radio stations, and for river-transport radio stations. These standards generally specify performance under normal conditions and extreme conditions on both sides, as in the case of temperature, or over ranges such as those of the various vibration parameters (frequency, acceleration). Tables 6.

[95-2415]

QUANTUM ELECTRONICS ELECTRO-OPTICS

UDC 621.791.72

MATHEMATICAL SIMULATION OF THERMAL PROCESSES INVOLVED IN ELECTRON-BEAM  
TREATMENT

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in  
Russian No 9, Sep 84 (manuscript received 20 Sep 83) pp 103-106

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[Abstract] Electron-beam welding is considered, specifically the performance required of the beam accelerating voltage. The analysis is based solely on the temperature field, with the three-dimensional quasi-linear Fourier equation of transient heat conduction in a moving medium replaced by a two-dimensional one applicable to thin strips and sheets. The negligible temperature variation across the thickness of welded pieces imposes a requirement of high precision on the accelerating voltage. The mathematical model for calculations refers to a rectangular steel strip to be heated by a surface source representing the spot struck by the electron beam, assuming a Gaussian current distribution over the beam cross section and a corresponding kind of heat source. The object of calculations is to determine the dependence of the temperature field, including the spot temperature as well as the mean temperature at the same axis, on the ripple frequency of the accelerating voltage. Change of aggregate state during the welding process is taken into account by introduction of the melting temperature as a singular point into the algorithm. These calculations yield the ripple factor for various ratios of spot diameter to strip thickness and, accordingly, the permissible range of mean welding temperature depending on the temperature ripple. The calculations have been programmed in FORTRAN for a YeS-1022 computer.

Figures 2; references: 4 Russian.

[77-2415]

SONICS & ULTRASONICS

UDC 534-8.001.4

NEW TYPES OF POWER SUPPLIES FOR ULTRASONIC PROCESSING EQUIPMENT

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 9, Sep 84 (manuscript received 20 Sep 83) pp 106-113

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[Abstract] A new power supply with a thyristor-type high-frequency inverter has been developed for high-power ultrasonic magnetostriuctive processing equipment. It meets the basic five requirements of smooth current and voltage buildup, sufficiently long recovery time, absence of parasitic high-frequency switching cycles, symmetric load current, and wide load regulation within a given frequency range. It consists of two 3-phase banks of charging thyristors with series inductances, two 3-phase banks of discharging thyristors with series inductances, one bank of three commutating capacitors, and output transformer, and a pair of voltage limiting diodes. The performance of this inverter has been evaluated on the basis of equivalent circuit diagrams for each characteristic period of the operating cycle of charging thyristors and discharging thyristors. Two experimental prototypes have been built and tested. Both the air-cooled 10 kW UZG1 and the water-cooled 25 kW UZG2 generate a voltage of  $440 \pm 10\%$  V at either  $18 \pm 1.35$  or  $22 \pm 1.65$  kHz. They can be used for treatment of liquids as well as in such manufacturing processes as wire and tube drawing. Figures 7; tables 2; references 5: 4 Russian, 1 Western.  
[77-2415]

TRANSPORTATION

UDC 629.4.053.3

MICROCOMPUTER-BASED AUTOMATIC DRIVING OF PASSENGER TRAIN

Moscow AVTOMATIKA, TELEMEKHANIKA I SVYAZ' in Russian No 8, Aug 84 pp 11-12

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[Abstract] A microcomputer system for automatic driving of electric passenger trains according to schedule is described which executes a run within  $\pm 30$  s accuracy with the most efficient use of electric energy. The control module, which also contains in addition to the microcomputer a velocity transducer, an automatic velocity regulator with digital-to-analog converter, a reprogrammable read-only memory, a pulse generator with power supply, and an indicator panel, can operate in the automatic control mode or in the advisory mode. The input data are the length of leg between stops and the scheduled run time, maximum permissible velocity, coasting velocity, length of coasting distance, and grade of precoasting track segment. The data array for automatic driving from Leningrad to Moscow on the "October Revolution" line is 650 bytes and its input into an "Elektronika P5" read-only memory is completed within 1 min. The system can be used on any kind of passenger-train locomotive with velocity regulator, including ER-200 electric locomotives. Figures 2. [95-2415]

NEW ACTIVITIES, MISCELLANEOUS

UDC 621.313.3

PROBLEMS IN DEVELOPMENT AND CONSTRUCTION OF MARINE SUPERCONDUCTING HOMOPOLAR ELECTRIC MACHINES

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 10, Oct 84 (manuscript received, after completion, 7 Jul 82) pp 44-50

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[Abstract] A major problem in the development and construction of large superconducting homopolar electric machines for ship propulsion is, in addition to the two general problems of efficient reliable current pickup and electromagnetic compatibility with adequate safety features, optimum speed regulation and reversibility of the propeller drive. A preliminary design and performance analysis has revealed the advantages of a cylindrical configuration over a disk configuration. A cylindrical armature with bar windings, two superconducting field coils in opposition, and solid brushes has been selected as the most promising design variant. The superconducting field coils and superconducting shield coils are placed inside the same cryostat, whose common wall is part of the machine housing. For this application, a 50 MW d.c. motor of this type appears to have better weight-size as well as technical-economic indicators than a comparable conventional d.c. motor. On the basis of extensive wear and life tests, silver-graphite brushes and copper-chromium alloy slip rings appear to be most suitable for operation in an atmosphere of  $\text{CO}_2 + \text{H}_2\text{O}$  atmosphere, with current densities up to  $870 \text{ A/cm}^2$  and at velocities up to 160 m/s. The problem of shielding for electromagnetic compatibility and safety is approached in two ways, with magnetostatic shields and with compensating windings, compensation alone often being adequate but suppression of the residual magnetic field sometimes requiring double-layer magnetostatic shields in addition. Figures 1; tables 1; references 16: 4 Russian, 11 Western.

[100-2415]

UDC 621.313.001:621.594

METHOD OF CALCULATING COOLDOWN PROCESS IN CRYOSTAT OF CRYOGENIC ELECTRIC  
MACHINE

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANika  
in Russian No 10, Oct 84 (manuscript date not given) pp 50-53

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[Abstract] Thermophysical processes in the cryostat of cryogenic electric  
machines during successive cooldown with nitrogen and helium are analyzed  
and the cryostat performance is calculated, taking into account the existence  
of heat transmission paths from the ambient medium to the magnetic  
structure. The thermal model of the machine includes the shield as an  
added mass. The mathematical model of the cooldown process consists of  
two differential equations of heat transfer for two heat exchangers in  
the system, each including heat conduction through structural components  
and heat radiation through vacuous cavities, and two algebraic equations  
of heat balance for these heat exchangers. This system of four equations  
with four unknown temperatures (temperature of magnetic structure,  
temperature of shield and adjacent shaft extension, two corresponding  
temperatures of coolant) is solved simultaneously. Numerical integration  
of the differential equations is performed with a variable step so as to  
cope with the fast decrease of thermal capacities upon approach to liquid  
helium temperatures. The algorithm of the solution has been programmed  
on a Yes-1022 computer. Typical results are compared with experimental  
cooldown curves for a cryogenic machine weighing 235 kg with a shield  
weighing 96 kg cooled with nitrogen down to 77 K and then with helium  
down to 4.3 K. Figures 2; references: 3 Russian.  
[100-2415]

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